Monitoring Radiation Aging of the DØ Silicon Detectors

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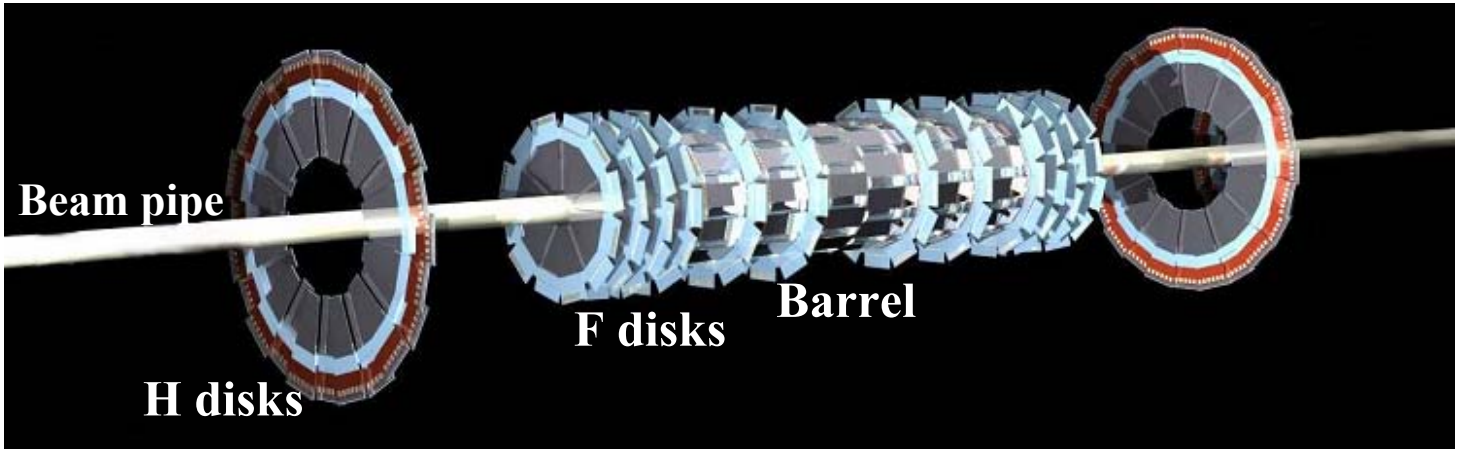
All Experimenters Meeting

Outline

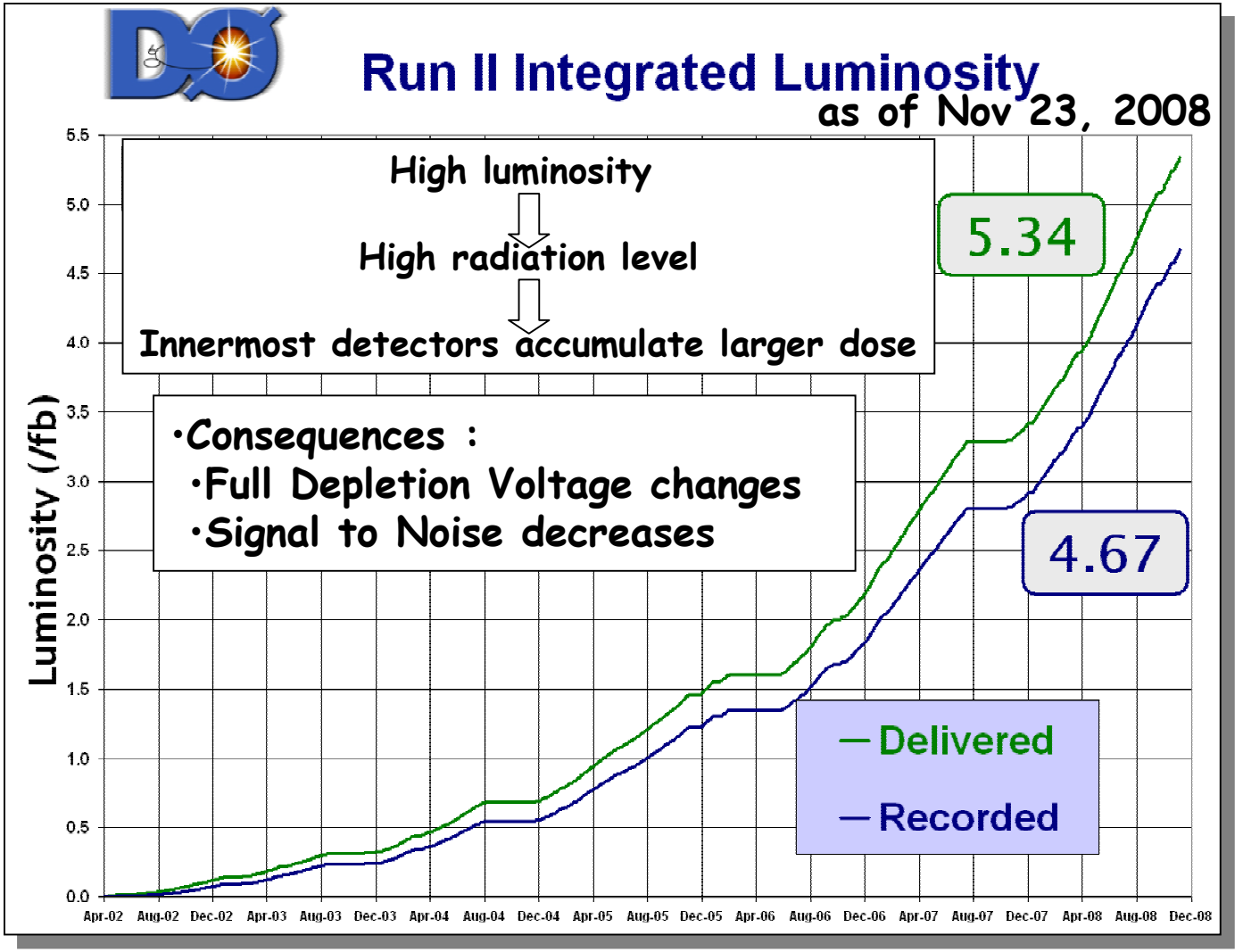
- Introduction
  - DØ Silicon Microstrip Tracker
  - Motivation
- Depletion Voltage
  - Depletion Voltage Measurement from Charge Collection Efficiency Studies
  - Projection to 8 fb^{-1}
- Summary

DØ Silicon Microstrip Tracker (SMT)

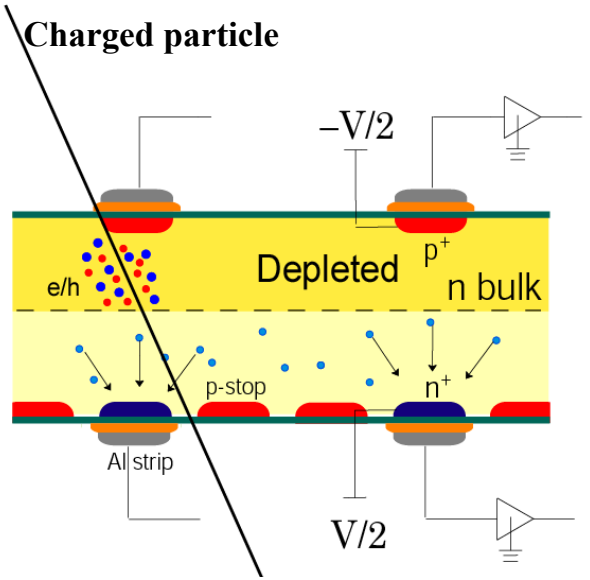


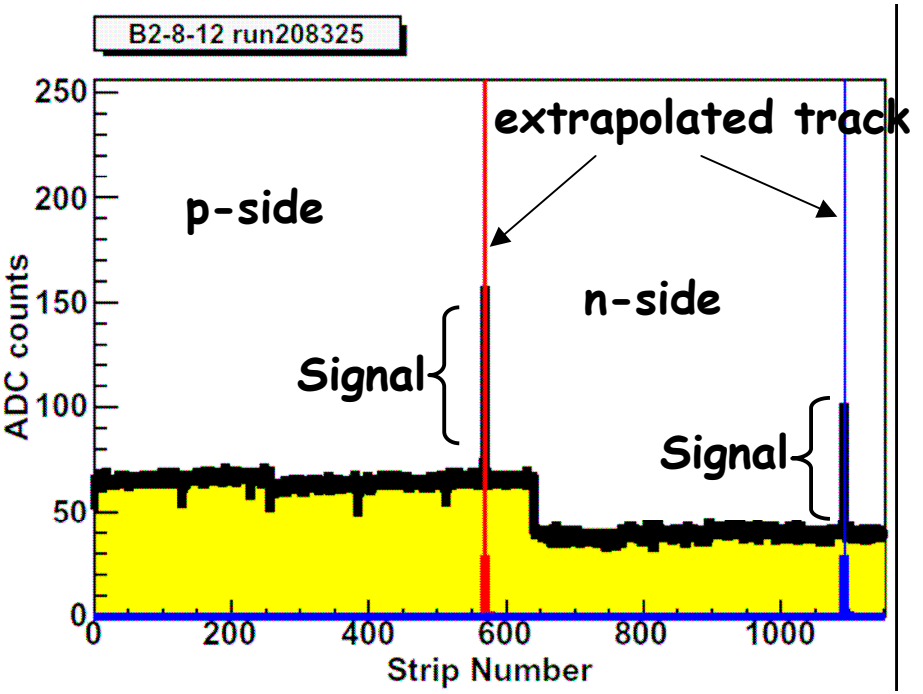
- Barrels
  - Original SMT : R=2.7 to 10.1 cm, 4 super layers(2 sub layers for each), various sensor types(Single-Sided, Double-Sided, Double-Sided Double-Metal)
  - Layer 0 (Installed in 2006) : R=1.6 to 1.7 cm, Single-Sided sensors
- Disks
  - 12 F-Disks : R=2.6 to 10.5 cm, Double-Sided sensors
  - 2 H-Disks : R=9.5 to 26 cm, Single-Sided sensors

Motivation

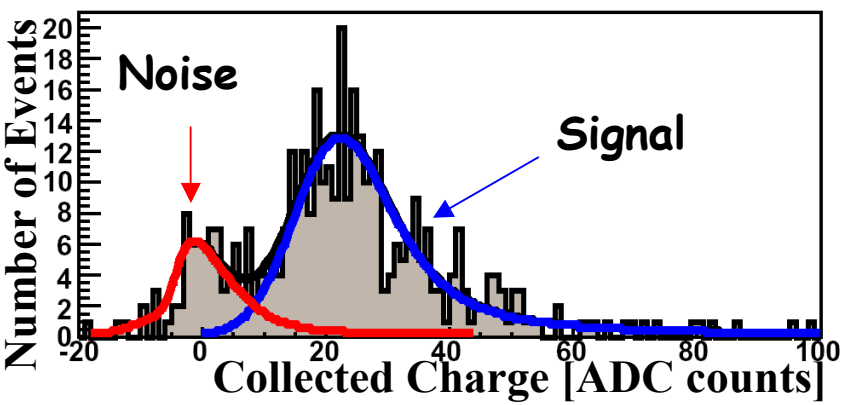

Run II Integrated Luminosity
as of Nov 23, 2008
High luminosity
High radiation level
Innermost detectors accumulate larger dose
•Consequences :
•Full Depletion Voltage changes
•Signal to Noise decreases
5.34
4.67
— Delivered
— Recorded
Luminosity (/fb)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Apr-02 Aug-02 Dec-02 Apr-03 Aug-03 Dec-03 Apr-04 Aug-04 Dec-04 Apr-05 Aug-05 Dec-05 Apr-06 Aug-06 Dec-06 Apr-07 Aug-07 Dec-07 Apr-08 Aug-08 Dec-08

Depletion Voltage Measurement from Signal Charge

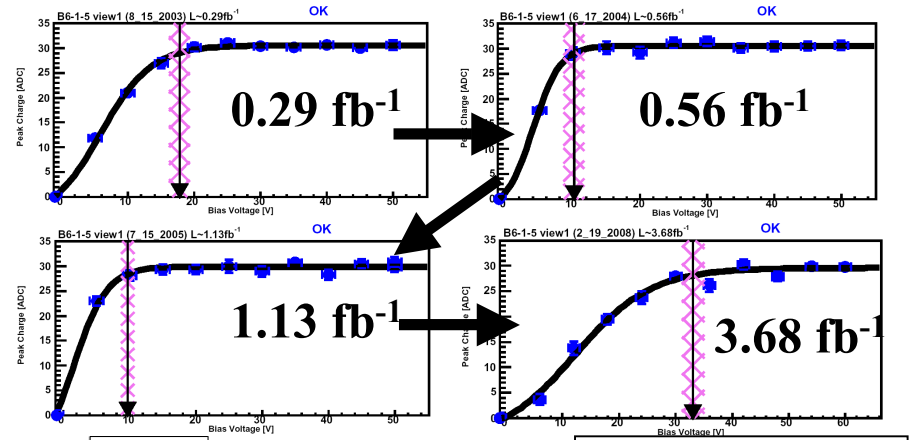


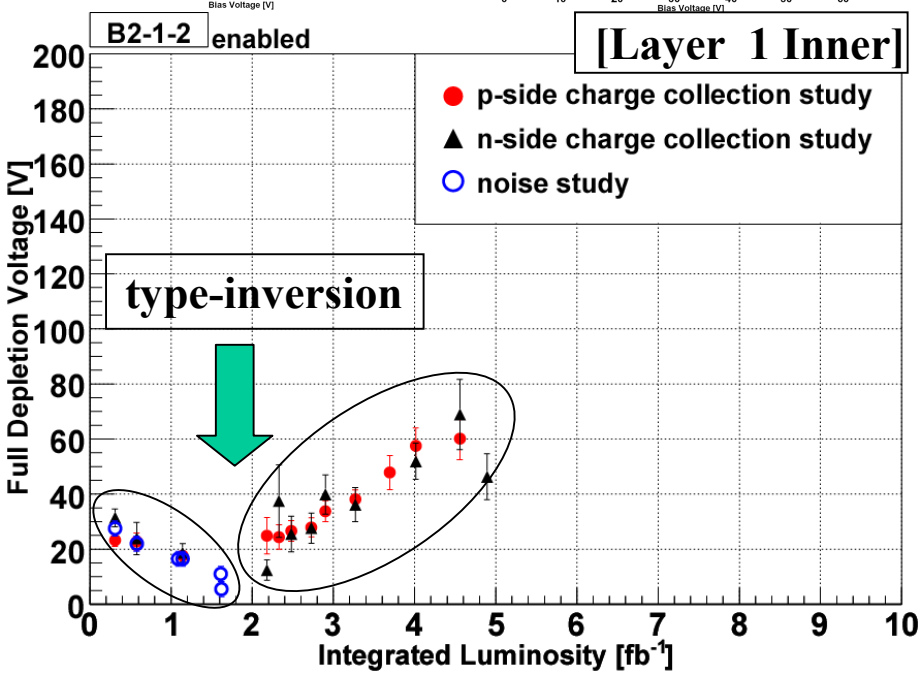


- Amount of collected charge depends on depleted volume
- If fully depleted, charge collection efficiency is maximized
- Take special runs to scan bias voltage and measure collected charge



Depletion Voltage Measurement from Signal Charge : cont'd





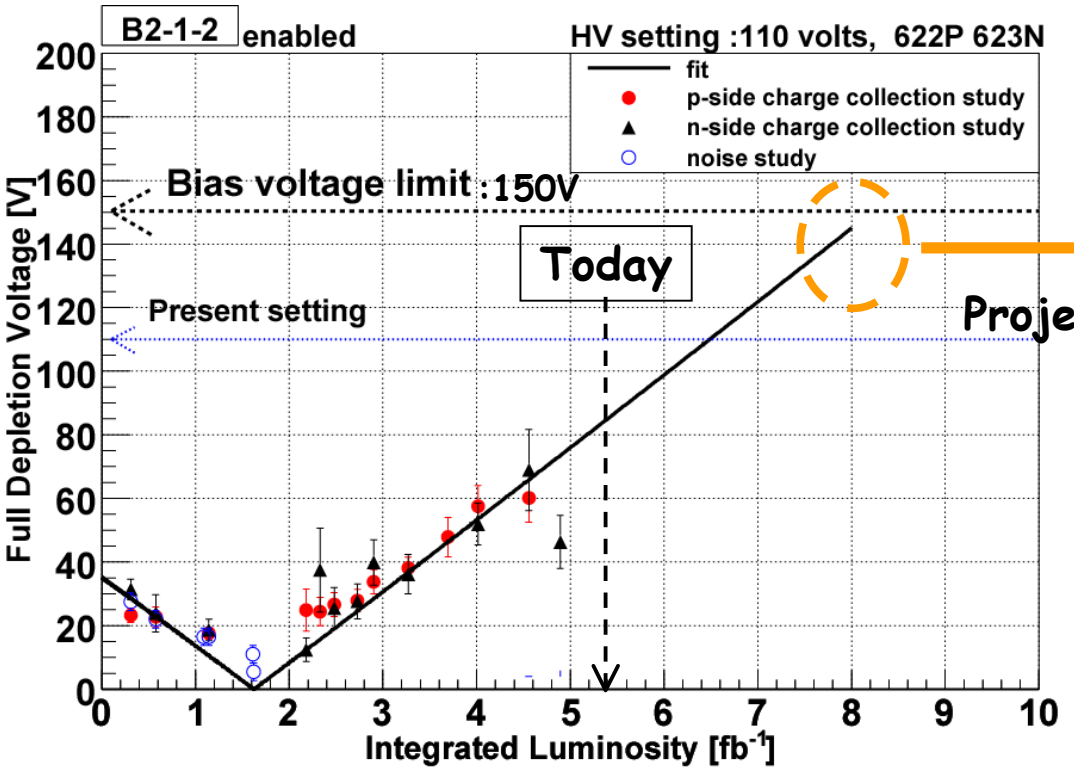
← Signal peak position as a function of bias voltage

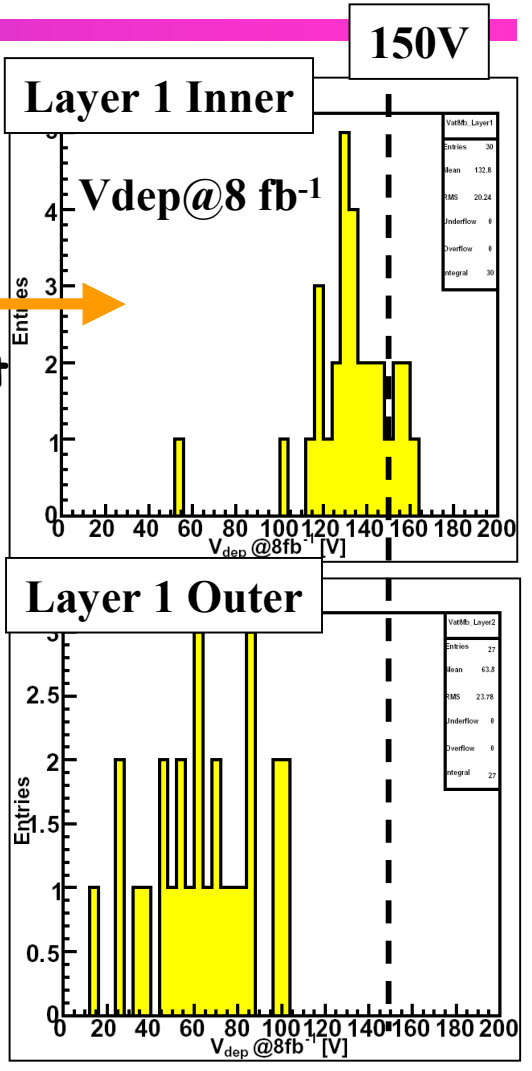
- Take the bias voltage at 95% charge collection efficiency as Full Depletion Voltage

- Consistent results between p-side and n-side measurements
- Studies of noise levels as a function of bias voltage also provide a means of assessing the full depletion voltage (prior to type-inversion)

➔ Consistent results

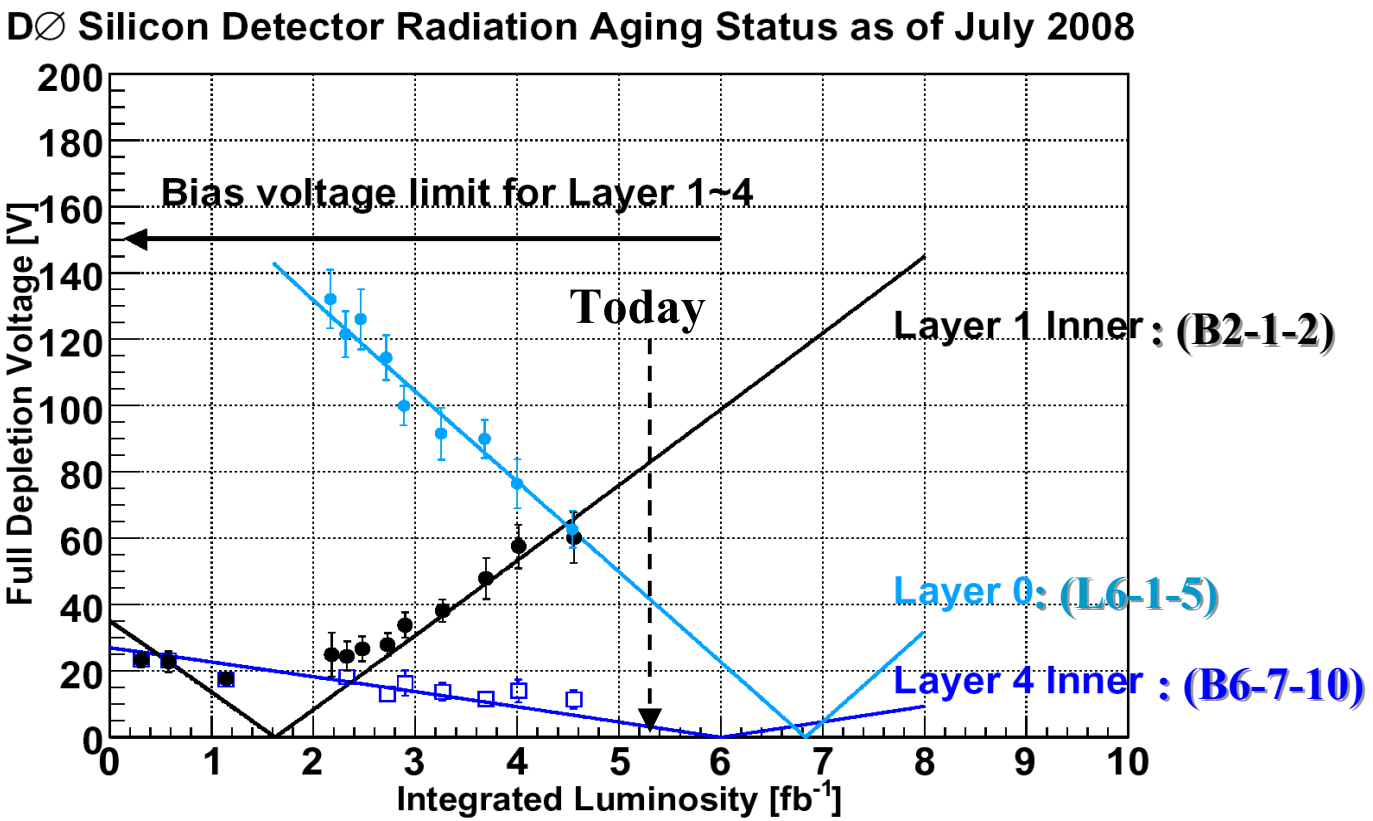
Projection to 8 fb^{-1}





- Project to 8 fb^{-1} by fitting existing data using Hamburg Model
- A few Layer 1 sensors might reach the bias voltage limit

Aging Status



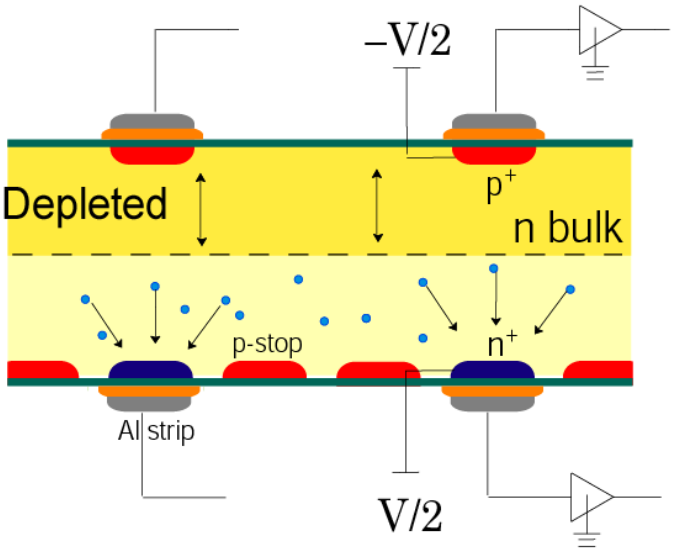
- ↑ Only showing data points from p-side charge collection study
- Layer 0 and outer layers will be fine through the end of RunII

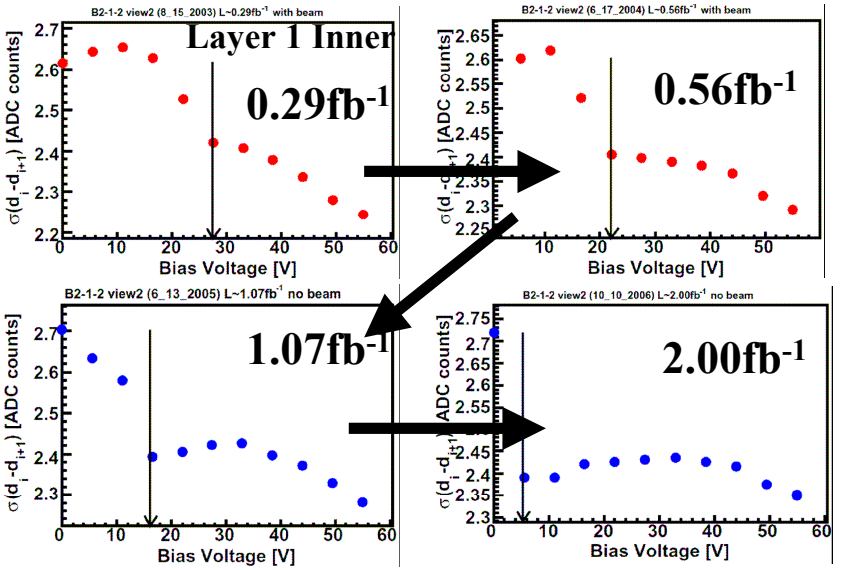
Summary

- SMT continues to perform well
- Monitoring radiation damage via bias scans
- A few of the inner Layer 1 sensors might not be fully depleted at 8 fb^{-1}
  - Layer 0 sensors installed to preserve tracking performance
- Expected to be able to continue fully depleting all other sensors through the end of RunII
- We will continue monitoring the impact of radiation on the silicon detector
  - Adjust bias voltages as necessary

Backup Slides

Depletion Voltage Measurement from Noise at n-strip side





- Bias voltage removes free charge carriers
- Strongly decreases at n-side when fully depleted
- This method works until the type-inversion point